Lung Injury Prediction Models to Improve Perioperative Management

Let's Hit the Bull's-eye!

IN this issue of ANESTHESIOLOGY, Kor *et al.*[1] report on the development of a new surgical lung injury prediction model for postoperative acute lung injury based on available preoperative risk factors. Of 4,366 patients investigated in that work, 113 (2.6%) developed acute lung injury after surgery. Predictors of postoperative acute lung injury in a multivariate analysis that were maintained in the final surgical lung injury prediction model included high-risk cardiac, vascular, and thoracic surgery, diabetes mellitus, chronic obstructive pulmonary disease, gastroesophageal reflux disease, and alcohol abuse. The surgical lung injury prediction score discriminated patients who developed early postoperative acute lung injury from those who did not with an area under the receiver operating characteristic curve (95% CI) of 0.82 (0.78–0.86), indicating that it may be useful to identify surgical patients at higher risk for pulmonary complications.

It has been estimated that worldwide approximately 234 million major surgical procedures are performed every year, with a major effect on the global economy. Among these interventions, approximately 2.6 million represent high-risk procedures, with 1.3 million patients developing complications that result in 315,000 in-hospital deaths.[2] In consideration of these numbers, safety in anesthesia and surgery must be seen as a global public-health issue[2] that has to be addressed. The assessment of the risk of development of postoperative pulmonary complications (PPCs) may represent a first step toward improved outcomes in the surgical patient population.

The incidence of PPCs varies greatly depending on the definition used, the category of patients as well as the kind of surgery, and the clinical treatment setting. Different entities and/or

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findings have been identified as a PPC, including respiratory failure from pulmonary and/or cardiac origin; pneumonia and/or respiratory infection; pleural effusion and atelectasis; pneumothorax; bronchospasm; and the need for noninvasive respiratory support or endotracheal (re)intubation.

PPCs are as common as cardiac complications after noncardiac surgery and are associated with prolonged hospital stay as well as higher mortality.[3] Clearly, strategies aimed at reducing PPCs are necessary. Multidisciplinary surgical safety checklists, which include data on the use of postoperative instructions, may be able to reduce PPCs. Unfortunately, checklists are not always easy to use. Furthermore, their suitability can vary according to the individual hospital and departmental characteristics, and the role of different interventions in a bundle is unknown.

Several strategies have been claimed to be effective in reducing the incidence of PPCs, including postoperative lung expansion maneuvers, preoperative intensive inspiratory muscle training, selective rather than routine use of nasogastric tubes, use of short-acting *versus* long-acting neuromuscular blockade, and laparoscopic instead of open bariatric surgery.

Postoperative lung expansion can be easily achieved with respiratory physiotherapy and/or noninvasive respiratory support by using continuous positive airway pressure or positive pressure ventilation. Other respiratory measures including early mobilization, deep inspiration exercises with or without incentive spirometry, and stimulation of cough may also be beneficial. However, their use is often based more on perceived efficacy than on scientific evidence. Preoperative lung expansion — also known as inspiratory muscle training — also has been proposed, but data are not definitive and

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possibly only applicable to cardiac surgery. Noninvasive continuous positive airway pressure seems to be effective to avoid PPC in patients with postoperative moderate hypoxemia. In addition, appropriate intraoperative hemodynamic monitoring, fluid administration strategies aimed at optimizing the volemic status, and early identification of sepsis may also improve outcome.

Despite the compelling rationale on the use of positive end-expiratory pressure as a means to prevent atelectasis during surgery, a recent meta-analysis suggested that such respiratory strategy is not effective for improving outcome in an unselected surgical population.[4] However, the question remains whether this figure could change in a population at higher risk for PPCs. Theoretically, the prevention of PPCs is most effective when interventions are used in patients at higher risk of developing complications, also permitting optimal allocation of resources and expenditure of efforts.

Different scores to predict PPCs have been developed but most are complex, precluding their clinical use. In a recent prospective observational study,[3] a total of 242 PPCs were recorded in 123 of 2,464 studied patients, *i.e.*, 5.0% of the total population. Seven independent variables were able to predict PPC: older age, low preoperative oxygen saturation, respiratory infection during the previous month, preoperative hemoglobin level less than 10 g/dL, upper abdominal or thoracic procedure, duration of surgery more than 2 h, and emergency procedure. Surprisingly, smoking and previous pulmonary disease were not present in the final prediction model (presumably, inclusion of oxygen saturation caused these other variables to "drop out" as independent predictors). The area under the receiver operating characteristic curve was 0.90 (95% CI, 0.85–0.94) for the development and 0.88 (95% CI, 0.84–0.93) for the validation subsample. All variables could be easily obtained during the preoperative visit, and that score was accurate for a wide population of patients. Interestingly, among the risk factors for PPC identified by those authors,[3] three are not listed in the evidence-based guidelines of the American College of Physicians: low preoperative SpO_2, recent respiratory infection, and preoperative anemia.

The score proposed by Kor *et al.* in this issue of ANESTHESIOLOGY[1] is attractive because it takes into account general surgical procedures, and includes only a few comorbidities and one single modifying condition. Nevertheless, the proposed prediction model has also limitations: intrinsic bias and confounding of a cohort-retrospective design; duration of anesthesia longer than 3 h; the limited number of respiratory failure cases and the low frequency of some potentially important risk factors may have masked important

associations; use of a heterogeneous study population; the single-center tertiary care nature of the institution providing care to the study population; and lack of external validation. Furthermore, it shares a common major limitation with similar scoring systems: that intraoperative events are not taken into account. Adverse events, such as excessive bleeding and hypotension, may affect the postoperative outcome and skew scores based solely on preoperative variables.[5]

Given the importance of the prediction of PPCs, both from a clinical and an economical perspective, validation not only of the surgical lung injury prediction but also other prediction models in independent studies is crucial before they can be used to guide interventions that may avoid such complications. Ideally, such validation should be conducted in different countries and the score applicable worldwide.

In conclusion, the development and validation of scores able to identify those patients who are at higher risk to develop pulmonary complications in the postoperative period, like the one proposed in the present issue of ANESTHESIOLOGY, are necessary to improve perioperative clinical management, thus reducing morbidity, length of hospital stay, and mortality of our patients, as well as saving resources. To hit the bull's-eye, one has to target it first.

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References

1. Kor DJ, Warner DO, Alsara A, Fernández-Pérez ER, Malinchoc M, Kashyap R, Li G, Gajic O: Derivation and diagnostic accuracy of the surgical lung injury prediction model. ANESTHESIOLOGY 2011; 115:117–128

2. Weiser TG, Makary MA, Haynes AB, Dziekan G, Berry WR, Gawande AA, Safe Surgery Saves Lives Measurement and Study Groups: Standardised metrics for global surgical surveillance. Lancet 2009; 374:1113–7

3. Canet J, Gallart L, Gomar C, Paluzie G, Vallès J, Castillo J, Sabaté S, Mazo V, Briones Z, Sanchis J, ARISCAT Group: Prediction of postoperative pulmonary complications in a population-based surgical cohort. ANESTHESIOLOGY 2010; 113: 1338–50

4. Imberger G, McIlroy D, Pace NL, Wetterslev J, Brok J, Moller AM: Positive end-expiratory pressure (PEEP) during anaesthesia for the prevention of mortality and postoperative pulmonary complications. Cochrane Database Syst Rev 2010; CD007922

5. Le Manach Y, Ibanez Esteves C, Bertrand M, Goarin JP, Fléron MH, Coriat P, Koskas F, Riou B, Landais P: Impact of preoperative statin therapy on adverse postoperative outcomes in patients undergoing vascular surgery. ANESTHESIOLOGY 2011; 114:98–104